

**APPLICATION FOR**  
**UNITED STATES PATENT**

in the name of  
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of

**Olin Corporation**

for

**DUAL CORE AMMUNITION**

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## DUAL CORE AMMUNITION

## CROSS-REFERENCE TO RELATED APPLICATION

This application claims benefit of U.S. Patent Application Ser. No. 60/294,169 filed 5 May 29, 2001 and entitled "Dual Core Ammunition." The disclosure of Ser. No. 60/294,169 is incorporated by reference herein as if set forth at length.

## BACKGROUND OF THE INVENTION

(1) Field of the Invention

10 This invention relates to small arms ammunition, and more particularly to bullets particularly useful in common calibers of centerfire pistol and revolver (collectively "pistol") ammunition.

(2) Description of the Related Art

15 A variety of cartridge sizes exist which may be used in pistols, rifles or both. Among key common pistol ammunition rounds are: .380 Automatic (also commonly designated 9 mm Kurz), 9 mm Luger (also commonly designated 9x19 and 9 mm Parabellum), .40 Smith & Wesson (S&W), .45 Automatic (also commonly designated Automatic Colt Pistol (ACP)) and 10 mm Automatic rounds. General dimensions of and pistol rounds are disclosed in *Voluntary Industry Performance Standards for Pressure and Velocity of Centerfire Pistol and Revolver Ammunition for the Use of Commercial Manufacturers* ANSI/SAAI Z299.3-1993 (American National Standards Institute, New York, NY). A newer round, the .357 Sig is also gaining acceptance.

20 After many decades of use of the .45 ACP round, in the 1980's the US Army adopted a 9 mm Luger full ogival, pointed, full metal case (FMC, a.k.a, full metal jacket (FMJ)) round as the standard round for use in military sidearms. The parameters for the M882 9 mm Luger rounds purchased by the US military are shown in United States Military standard MIL-C-70508, the disclosure of which is incorporated by reference in its entirety herein as if set forth at length.

25 Historically, pistol bullets have been of all lead or of jacketed lead constructions. More recently, environmental toxicity concerns have led to the development of lead-free alternatives.

30 Various powder metallurgy alternatives to lead bullets are disclosed in U.S. Pat. No. 5,399,187 of Mravic et al.

U.S. Pat. Nos. 5,500,183 of Noordegraaf et al. and 6,016,754 of Enlow et al. disclose use of tin-based bullets and cores thereof.

International Application PCT/US96/17664 (WO97/20185) of Olin Corporation and Valdez et al. discloses a number of lead-free dual core pistol bullets. Among examples are 5 bullets having rear cores of sintered copper-ferrotungsten and front cores of lead or calcium carbonate powder.

#### BRIEF SUMMARY OF THE INVENTION

I have developed a novel manufacturing technique and applied it to the manufacture of 10 novel bullets. A jacket precursor, a first core precursor, and a second core precursor are provided. The first and second core precursor are inserted into the jacket precursor. The second core precursor is pressed against the first so as to deform the first to fill a frontal volume of the jacket precursor as a first core with relatively less (if any) deformation of the second core precursor. An aft portion of the jacket precursor is deformed to contain the second core precursor as a second core. 15

Preferred embodiments are formed substantially as drop-in replacements for existing bullets. To achieve the desired mass at a given ogival contour, the portion of the bullet aft of the ogive may be a bit longer than the replaced bullet and may be seated deeper in the case. A match embodiment features a lead rear core and a very light front core (e.g., a carbonate powder). A non-toxic embodiment comprises a tin front core and a harder rear core. The first core precursor may be formed as a pellet and, more particularly, a spherical pellet. The second core precursor may be formed having a cylindrical portion and one or two convex end portions. 20

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of 25 the invention will be apparent from the description and drawings, and from the claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cut away view of a pistol cartridge.

FIG. 2 is a cross-sectional view of a bullet useful in the cartridge of FIG. 1.

FIGS. 3-7 are longitudinal cross-sectional views of intermediate manufacturing stages 30 of the bullet of FIG. 2.

FIG. 8 is a longitudinal cross-sectional view of a second bullet.

FIGS. 9-10 are longitudinal cross-sectional views of intermediate manufacturing stages of the bullet of FIG. 8.

Like reference numbers and designations in the various drawings indicate like elements.

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## DETAILED DESCRIPTION

FIG. 1 shows , a cartridge 20 including a case 22, a bullet 24, a propellant charge 26, and a primer 28. Preferably, the case and primer are of conventional dimensions and materials such as those of the M882 round. In the illustrated embodiment, the case is unitarily formed of brass and is symmetric about a central longitudinal axis 100 it shares with the bullet. The case includes a wall 30 extending from a fore end 32 to an aft end 34. At the aft end of the wall, the case includes a head 36. The head has front and aft surfaces 38 and 40. The front surface 38 and the interior surface 41 of the wall 30, define a cavity configured to receive the propellant charge 26. The head has surfaces 44 and 46 defining an approximately cylindrical primer pocket extending forward from the aft surface 40. The head has a surface 48 defining a flash hole extending from the primer pocket to the cavity. In the illustrated embodiment, the surface 48 and flash hole 49 defined thereby are cylindrical, e.g., of uniform circular cross-section.

The primer 28 includes a metal cup formed as the unitary combination of a sleeve portion and a web portion spanning the sleeve at an aft end of the sleeve. Preferably a nontoxic, lead-free (e.g., dinol-based) primer charge is contained within the cup along a forward surface of the web. Forward of the primer charge, an anvil is disposed across the cup and has aft and forward surfaces and at least one venting aperture (vent) extending between such surfaces. A paper disk or foil is disposed on the aft surface of the anvil.

I have conceived a first embodiment of a bullet offering improved accuracy such as for use in target or match competition. The illustrated bullet 24 (FIG. 2) consists essentially of a metallic jacket 70, a frontal core 72, and a rear core 74. It is well recognized within the industry that the pointed FMC design such as employed for the M882 round is inherently inaccurate. One of the major geometric parameters affecting accuracy is the location of the bullet's center of gravity (CG) with respect to the nose surface. Accuracy of spin stabilized bullets improves as this distance increases. One method commonly employed to increase this distance is to remove a cylindrical section of the core from the nose (including the jacket material covering the section) and relocating the mass to the rear of the bullet to maintain comparable weight. This is typically referred to as a hollow point design. Another method is to flatten the nose, essentially creating a meplat. The bullet's drag increases and consequently changes the location

of the center of pressure (CP). The CP is now closer to the frontal surface and further from the CG. The greater the spread in location of the CG and CP, the quicker the bullet will stabilize from any initial yaw and thus more accurately follow the trajectory as determined by the weapon's point of aim.

5       The first present embodiment improves accuracy of the bullet by moving the CG rearward by replacing a portion of the high-density core material, such as lead, with a lower density material. For example, the front (nose) core 72 may be 2.5 grains of sodium carbonate while the rear core 74 may be 107.5 grains of lead and the jacket 14.0 grains of brass. The bullet is consequently slightly longer if desired to maintain a similar mass but the CG is now  
10      relocated rearward. For example, the 9mm (124 grain) FMC bullet used in the M882 cartridge has its CG located 1.00 caliber from the nose surface whereas with the first embodiment example it is 1.18 calibers (an 18% relative shift). In a side-by-side test the M882 round had an average 10 shot dispersion of 3.6 inches at 50 yards whereas the first embodiment example had only 1.9 inches for a 46% improvement. This is consistent with the estimated improvement in dispersion as calculated by PRODAS - an exterior ballistic computer program produced by  
15      Arrow Tech Associates.

In an exemplary method of manufacture, the jacket 70 is initially formed as a relatively right bullet jacket cup (FIG. 3). This initial jacket precursor is pressed into a die (not shown) having the desired ogive and nose profile with a punch (not shown) containing the desired inside profile. This forms the jacket into a secondary precursor stage (FIG. 4). The outside and inside surface contours along at least a forward portion thereof are advantageously not altered as a result of subsequent bullet forming operations. The cores (more particularly as core  
20      precursors) are inserted into the jacket preform (FIG. 5). In general, the greater the difference in densities of the two cores, the greater will be the rearward relocation of the CG in the assembled bullet. Preferred nose core material is powdered sodium carbonate consolidated into a core precursor pellet of spherical shape. The powder may include a small amount of wax or other binder to maintain integrity of the pellet during initial handling. Other materials are acceptable. They would preferably have a density less than 3.0 grams per cubic centimeter.  
25      They would also preferably be relatively inert and non-toxic. A spherical shape is preferred since its surface 73 will contact the jacket interior surface 71 to self align along the central axis (geometric centerline) when inserted into the jacket preform and thus maintain the overall CG position on such axis.

In its initial precursor state, the rear core 74 advantageously has at least a convex front surface 75 and may have a similarly convex rear surface 76. A cylindrical lateral surface 77 may join the two. Front-to-back core symmetry eliminates the need to orient a unique front end around the front core precursor. The radius of curvature  $R_c$  of the front surface is

5 advantageously between the radius  $R_1$  of the rear core precursor (i.e., such as would form the rear core into an obround with domed hemispheric ends) and approximately the diameter (i.e.,  $2R_1$ ) of the rear core precursor. This profiling helps avoid damage to or deformation of the soft lead core during handling prior to compaction (e.g., prior to and during insertion) by effectively breaking the edge which would be associated with a flat-ended cylinder. Other breaking of the  
10 edge, such as by chamfering, may provide some of this benefit.

The hardness/strength of the low density pellet should be less than that of the rear core precursor in order for it to be pulverized back to its original powdered form during consolidation (FIG. 6) and thus deform to assume the profile of the rear core's front end surface along a portion 80 and the ogival nose portion of the jacket interior surface 71 along a portion 81. Tests have shown that the sodium carbonate sphere will crush at about five pounds force (lb.*f*) whereas the rear lead core will not deform until at least 50 lb.*f* is applied whereupon the sphere has already deformed to fill the space allocated for the low density material. As the force applied to the rear surface of the rear core is increased, the diameter of the rear core expands to laterally fill the interior volume of the jacket (e.g., at a force in excess of 200 lb.*f*). The bullet is then coned (FIG. 7) and finish assembled (FIG. 8) using standard forming tools and techniques.

In general, the volume of the low density front core should be sufficient, given its density, to provide the desired rearward shift in CG. This will typically be well under 50% of the internal volume of the jacket. A range of 5-40% is likely, with 10-20% being more narrow.

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A similar manufacturing process may be used to manufacture a lead free non-toxic bullet 124 (FIG. 8). Key examples duplicate the weight and ogival profile of existing pointed FMC bullets so as to provide a drop-in replacement which may have a slightly different length aft of the ogive. In one embodiment, the front core 172 consists of a soft malleable material  
30 (e.g., having a hardness less than Brinell 10). The rear core 174 is likely harder than the front core and has a density of at least 75% that of lead. Preferred materials are: tin for the front core; and tungsten-filled nylon resin having a density of 10.2g/cc for the rear. Exemplary material is available from RTP Company, Winona, Minnesota and is believed to contain a small amount of

copper in addition to tungsten.

An exemplary lead-free M882 replacement could include front and rear core masses of 12.0 and 98.0 grains, respectively. Other materials for the front core could include rubber, 5 silicone, glazing putty, and consolidated inert powders such as used in the match bullet. The rear core could comprise nickel, copper, and consolidated iron/tungsten powder partially sintered. To the extent that the nature of the rear core material is allowed to be a little stronger than lead in resisting handling damage, the core may more easily be formed as a cylinder without convex ends. Advantageously, in addition to being non-toxic, this bullet duplicates the 10 penetration performance of the lead-core bullet being replaced. It is particularly desirable that the bullet not penetrate body armor (e.g., of aramid fiber) as worn by law enforcement personnel to a greater extent than the lead core bullet. The National Institute of Justice, U.S. Dept. of Justice has set minimum performance standards for body armor as detailed in NIJ Standard 0101.04, "Ballistic Resistance of Police Body Armor". The standard states that a 15 Level 2 grade of body armor will offer protection against all handgun ammunition except 44 Magnum, which requires a Level 3A to prevent injury to the wearer. A test conducted in accordance with the NIJ standard has confirmed that a Level 2 body armor will stop the M882. However, if the entire bullet core consists of a material having a hardness greater than Brinell 20 no deformation of the bullet's nose profile will occur and the bullet will pass through the armor. It will also defeat Level 3A protection. Under similar conditions, the tin-nosed M882 replacement bullet 124 met the NIJ requirement.

In general, the volume of the front core should be sufficient to permit sufficient nose distortion at impact to not penetrate a desired level of body armor. This will typically be well under 50% of the internal volume of the jacket. A range of 5-40% is likely, with 10-20% being 25 more narrow.

The exemplary non-toxic bullet 124 is produced in a similar manner to the match bullet 24 except that the rear core precursor 174 is more cylindrical and initially contacts the jacket inside surface and not the front core precursor 174 (FIG. 9). As force is exerted on the rear surface of the rear core precursor the front surface deforms and follows the contour of the 30 jacket interior surface, and then the front core precursor consolidating the tin into the nose and in front of the rear core precursor (FIG. 10). An exemplary 100 lb.*f* force is required to completely deform the tin sphere and 500 lb.*f* to expand the rear core precursor to fill the inside profile of the bullet. If the initial rear core precursor diameter is too small, the tin would

be forced rearward between the rear core precursor and the jacket thus reducing its effectiveness. The remaining steps in forming the bullet (e.g., coning and finishing) are similar to those used in completing the match bullet.

- 5        One or more embodiments of the present invention have been described. Nevertheless, it will be understood that various modifications may be made without departing from the spirit and scope of the invention. For example, although certain advantages may be particularly relevant within certain existing calibers of ammunition and associated specifications, the inventive bullets may be applied to other calibers and specifications either present or future.
- 10      Additions of features such as sealing disks, coatings, and the like may also be useful for particular applications. Accordingly, other embodiments are within the scope of the following claims.